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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

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TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

0979567
NOT YET KNOWN

INTERNATIONAL APPLICATION NO.

PCT/DE00/01267

INTERNATIONAL FILING DATE

25/APRIL/2000

PRIORITY DATE CLAIMED

23/APRIL/1999

TITLE OF INVENTION

ASSEMBLY FOR MONITORING THE PERFORMANCE OF D WDM MULTI FREQUENCY SYSTEMS

APPLICANT(S) FOR DO/EO/US

Aldalbert BANDEMER and Dieter PALME

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☒ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (Unsigned)
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☒ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information: Cert/Express Mail
Copy of: International Search Report
PCT/ISA/210
PCT/IPEA/409

PATENT
22 OCT 2001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: BANDEMER, A., et al.

International Application No.: PCT/DE00/01267

International Filing Date: 25/APRIL/2000

U.S. Serial No.: (to be accorded)

U.S. Filing Date: October 22, 2001 (i.e., herewith)

For: ASSEMBLY FOR MONITORING THE PERFORMANCE
OF D-WDM MULTI-FREQUENCY SYSTEMS.

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231
ATTN: BOX PCT

Sir:

Prior to examination and before calculating the filing fees due, please amend the accompanying patent application as follows:

IN THE CLAIMS:

Amend the claims to read as follows. No new matter is presented. A version is attached showing the changes made.

1(amended). An arrangement for monitoring the performance of D-WDM multiple wavelength systems, wherein signals are applied to a controllable wavelength demultiplexer for channel separation, which has associated photodetectors for signal verification, whose signals are applied to an evaluation unit.

2(amended). The arrangement as claimed in claim 1, wherein the number of said photodetectors corresponds to a number of channels of the demultiplexer.

3(amended). The arrangement as claimed in claim 1, wherein a same number of photoreceivers are used at multiple channel outputs of the demultiplexer.

4(amended). The arrangement as claimed in claim 1, further comprising a polarization manipulation device connected upstream of the wavelength demultiplexer along a signal path.

5(amended). The arrangement as claimed in claim 1, wherein a passband characteristic of the demultiplexer can be varied cyclically with respect to at least one wavelength.

6(amended). The arrangement as claimed in claim 5, wherein the passband characteristic is varied by thermal modulation of a characteristic of a component of the arrangement.

7(amended). The arrangement as claimed in claim 1, wherein the demultiplexer comprises a phased array demultiplexer.

8(amended). The arrangement as claimed in claim 1, comprising an array of photodiodes.

9(amended). The arrangement as claimed in claim 8, the photodiode array has of one of a monolithic construction and a hybrid construction.

10(amended). The arrangement as claimed in claim 4, comprising a polarization scrambler connected upstream of the demultiplexer along the signal path.

11(amended). The arrangement as claimed in claim 4, comprising a polarization switch connected upstream of the demultiplexer along the signal path.

12 (amended). The arrangement as claimed in claim 4, wherein the polarization manipulation device operates synchronously with data detection and processing.

REMARKS

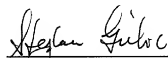
This Preliminary Amendment is made to place the accompanying application in better form for examination according to US practice. The claims have been amended to eliminate informalities. A version of the claims showing the changes is attached. No new matter is presented.

The number of claims presented is within that permitted under the basic filing fee. Please enter the Preliminary Amendment prior to examination and before calculating the filing fees.

Prompt examination is requested.

Respectfully submitted,

Date: Oct. 22, 2001



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Docket No: 3212-25 (D4772-00020)

Version Showing Changes

1(amended). An arrangement for monitoring the performance of D-WDM multiple wavelength systems, wherein ~~[characterized in that the]~~ signals are applied to a controllable wavelength demultiplexer ~~[(2)]~~ for channel separation, which has associated photodetectors ~~[(4)]~~ for signal verification, whose signals are applied to an evaluation unit.

2(amended). The arrangement as claimed in claim 1, wherein ~~[characterized in that]~~ the number of said photodetectors ~~[(4)]~~ corresponds to a ~~[the]~~ number [n] of channels of the demultiplexer.

3(amended). The arrangement as claimed in claim 1 ~~[claims 1 or 2]~~, wherein ~~[characterized in that the]~~ a same number of photoreceivers are used at ~~[the]~~ multiple channel outputs of the demultiplexer.

4(amended). The arrangement as claimed in claim 1 ~~[one of claims 1 to 3]~~, further comprising ~~[characterized in that the]~~ a polarization manipulation device ~~[(12;13)]~~ is connected upstream of the wavelength demultiplexer along a signal path.

5(amended). The arrangement as claimed in claim 1 ~~[one of claims 1 to 3]~~, wherein ~~[characterized in that the]~~ a passband characteristic of the demultiplexer ~~[(2)]~~ can be varied cyclically with respect to ~~[the]~~ at least one wavelength.

6(amended). The arrangement as claimed in claim 5, wherein ~~[characterized in that]~~ the passband characteristic is varied by thermal modulation of a characteristic of a ~~[the]~~ component ~~[characteristics]~~ of the arrangement.

7(amended). The arrangement as claimed in claim 1 ~~(one of claims 1 to 6),~~
wherein ~~[characterized in that the]~~ the demultiplexer ~~[(2) is in the form of]~~ comprises a
phased array demultiplexer.

8(amended). The arrangement as claimed in claim 1 ~~(one of claims 1 to 6),~~
comprising ~~[characterized in that the]~~ an array of photodiodes ~~[is used].~~

9(amended). The arrangement as claimed in claim 8, ~~[characterized in that]~~ the
photodiode array has ~~[is]~~ of one of a monolithic construction and a ~~[or]~~ hybrid
construction.

10.(amended). The arrangement as claimed in claim 4 ~~(one of claims 1 to~~
~~6),~~ comprising ~~[characterized in that the]~~ a polarization scrambler ~~[(12) is]~~ connected
upstream of the demultiplexer along the signal path.

11.(amended). The arrangement as claimed in claim 4 ~~(one of claims 1 to~~
~~9),~~ comprising ~~[characterized in that the]~~ a polarization switch ~~[is]~~ connected upstream
of the demultiplexer along the signal path.

12.(amended). The arrangement as claimed in claim 4 ~~(one of claims 4 to~~
~~14),~~ wherein ~~[characterized in that]~~ the polarization manipulation device operates
synchronously with ~~[,]~~ data detection and processing ~~[operate synchronously].~~

: 10 Rec'd POT/PTO 22 OCT 2001

Arrangement for monitoring the performance of
D-WDM multiple wavelength systems

DESCRIPTION

Technical field

The invention relates to an arrangement for monitoring the performance of D-WDM multiple wavelength systems.

D-WDM systems are known, for example, from the Company Document "Basiswissen D-WDM Systeme" [Basic knowledge relating to D-WDM systems], from Profile Optische Systeme GmbH, DE, January 1999. Reference is expressly made to this Company Document, in general, in order to explain all the details which are not described in relatively great detail here.

In D-WDM systems - Dense Wavelength Division Multiplex, also referred to as densely packed WDM systems or dense WDM systems - information and/or messages is/are transmitted via light signals at different wavelengths via only one fiber. Each wavelength is the carrier for one information signal.

In currently available systems, all the channels are within the wavelength band from about 1 520 nm to 1 565 nm. Further

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developments are intended to allow use of an expanded wavelength band from about 1 390 nm to 1 650 nm. The channel separation in this case is only a few nanometers, or a few hundred picometers. In order to standardize these telecommunications systems, the International ITU-T Working Group have recommended that the wavelengths (that is to say the channels) to be used be standardized with a channel separation of 100 GHz (which corresponds to 0.8 nm).

Prior art

Arrangements for continuous monitoring of all the characteristic parameters are required at many points in this transmission system. Where necessary, continuous monitoring allows specific signal regeneration or improvement, and rapid reaction to defects and failures.

The most important parameters in this case include the wavelength and the power, the wavelength drift of the laser, and the signal-to-noise ratio in each transmission channel. Typical specification requirements for monitoring are, in this case:

- wavelength measurement in each channel with an absolute accuracy of 0.08 nm and a resolution of 0.01 nm,
- power measurement in each channel with an absolute accuracy of 0.5 dB, and a resolution of 0.1 dB,

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- signal-to-noise measurement between the channels with an absolute accuracy of 0.4 dB, repeatability of 0.1 dB, and a dynamic range of at least 33 dB,
- reliability over 10^{16} measurement cycles (approximately 20 years),
- low PDL (0.1 dB maximum),
- measurement virtually in real time.

In principle, two different methods are suitable for monitoring: the filtering technique and the interferometer technique. Both are used in conventional optical spectrum analyzers.

In the filtering technique, tunable narrowband filters are used for wavelength selection. Acousto-optical filters (for example from the company Wandel & Goltermann) or piezo-electrically controlled microfilters (for example from the company Queensgate) are used, which can be tuned directly via an electrical variable. A further variant is the grating monochromator technique, in which, as one option, the grating is rotated and the three-dimensionally resolved signal spectrum is sampled using a single photodiode; alternatively, the grating can be fixed, with a scanning deflection mirror being provided in front of the output gap in the monochromator (for example from the company Photonetics). Furthermore, a fixed grating can be used, together with a row

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of photodiodes as the detector unit (for example from the company Yokogawa).

In the interferometer technique, the spectrum is obtained from the detector signal from a Michelson interferometer with variable path lengths by means of Fourier transformation (for example from the company Hewlett Packard).

None of the conventional arrangements that have been mentioned is suitable for satisfying the stringent requirements relating to resolution, measurement accuracy, ASE measurement and dynamic range placed on a monitoring assembly for a WDM system at the same time and in a suitable manner and, furthermore, for complying with the requirements for a short measurement time, long life and occupancy of only a small amount of space.

Description of the invention

The aim of the invention is to provide a suitable compact measurement system which allows permanent and parallel monitoring of the frequency, power, drift and SNR (signal-to-noise ratio) in the channels of a D-WDM system, with measurement times in the millisecond range.

One solution to this task according to the invention is specified in claim 1. Developments of the invention are the subject matter of claim 2 and the subsequent claims.

According to the invention, a specific D-WDM technology demultiplexer is used, combined with an array of photo-detectors.

Use is preferably made of the characteristic of a phased array demultiplexer that the channel mid-frequencies of such a demultiplexer can be varied in a defined manner by varying the temperature. If the temperature is varied cyclically in time, and this is measured at the same time, then the mid-frequencies of each separate channel can be allocated uniquely.

The filter profile of each channel in the demultiplexer is Gaussian. The output signal from the photodetector arranged at each channel output is the mean value, with regard to time, over the spectral function that is applied, and is weighted by the filter function. With the knowledge of the weighting function (Gaussian passband curve with respect to the wavelength) and the instantaneous mid-frequency (which is variable with time by temperature control), it is possible to determine the following parameters:

- central wavelength and time drift of the optical carrier,

- optical power and change with time,
- spectral power densities outside the user bands, in order to establish the signal-to-noise ratio.

The system contains no moving parts. The channels to be monitored are separated by means of an assembly with integrated optics. Parallel data acquisition ensures short measurement times. The assemblies used are largely insensitive to polarization. The system has negligible reactions. The measurement system is compact. Influences on the measurement accuracy from undefined polarization directions of the spectra to be measured are prevented by connecting a device for polarization manipulation upstream. Devices which vary the polarization direction randomly (polarization scramblers) and polarization switches can be used for this purpose.

Brief description of the drawing

The invention will be described in more detail in the following text using exemplary embodiments and with reference to the drawing, in which:

Figure 1 shows the basic design of a D-WDM monitor,

Figure 2 shows the design of a D-WDM monitor with a phased array demultiplexer,

Figure 3 shows the design of a D-WDM monitor with a phased array demultiplexer and an upstream polarization scrambler,

Figure 4 shows the design of a D-WDM monitor with a phased array demultiplexer and an upstream polarization switch.

Description of exemplary embodiments

Figure 1 shows the basic design of a D-WDM monitor. The D-WDM spectrum to be investigated is fed in at the fiber input (1) of a demultiplexer (2). The demultiplexer (2) separates n channels at its output; the number n depends on the number of outputs specified for this component. Instead of the n output fibers which are normally present at the outputs, n photo-detectors (4) are fitted, each of which detects the radiation of one of the output channels from the demultiplexer (2). The electrical signals are supplied on n channels (5) to the evaluation unit (6) and to the display and control unit (7). The passband characteristic of the demultiplexer (2) is varied cyclically via a modulation device (3) by means of feedback (8) from the display and control unit (7). This variation acts exclusively on the passband wavelength of each individual channel.

In Figure 2, the demultiplexer (2) is a phased array demultiplexer, whose characteristic is varied by substrate heat treatment (10). The instantaneous temperature is measured via an integrated sensor (11), whose signal (9) is evaluated by the display and control unit (7), and is used for sequence control.

Figure 3 shows an arrangement in which the polarization direction, which is not necessarily fixed, of the input signal is distributed randomly by means of a polarization scrambler (12), in order in this way to avoid polarization-dependent measurement errors.

In Figure 4, the scrambler is replaced by a polarization switch (13), which switches cyclically and synchronously with the data acquisition and processing between two orthogonal polarization states and, by means of a further polarizer, provides a defined polarization state to the input of the phased array. This makes it possible to exclude measurement errors resulting from changing polarization directions in the input signal.

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PATENT CLAIMS

1. An arrangement for monitoring the performance of D-WDM multiple wavelength systems,
characterized in that the signals are applied to a controllable wavelength demultiplexer (2) for channel separation, which has associated photodetectors (4) for signal verification, whose signals are applied to an evaluation unit.
2. The arrangement as claimed in claim 1,
characterized in that the number of photodetectors (4) corresponds to the number n of channels.
3. The arrangement as claimed in claim 1 or 2,
characterized in that the same number of photoreceivers are used at the multiple channel output of the multiplexer.
4. The arrangement as claimed in one of claims 1 to 3,
characterized in that a polarization manipulation device (12; 13) is connected upstream of the wavelength demultiplexer.
5. The arrangement as claimed in one of claims 1 to 3,

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characterized in that the passband characteristic of the demultiplexer (2) can be varied cyclically with respect to the wavelength.

6. The arrangement as claimed in claim 5, characterized in that the passband characteristic is varied by thermal modulation of the component characteristics.
7. The arrangement as claimed in one of claims 1 to 6, characterized in that the demultiplexer (2) is in the form of a phased array demultiplexer.
8. The arrangement as claimed in one of claims 1 to 6, characterized in that an array of photodiodes is used.
9. The arrangement as claimed in claim 8, characterized in that the photodiode array is of a monolithic or hybrid construction.
10. The arrangement as claimed in one of claims 1 to 9, characterized in that a polarization scrambler (12) is connected upstream of the demultiplexer.
11. The arrangement as claimed in one of claims 1 to 9,

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characterized in that a polarization switch is connected upstream of the demultiplexer.

12. The arrangement as claimed in one of claims 4 to 11, characterized in that the polarization manipulation device, data detection and processing operate synchronously.

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ABSTRACT

An arrangement is described for monitoring the performance of D-WDM multiple wavelength systems.

The arrangement according to the invention is distinguished in that the signals are applied to a controllable wavelength demultiplexer for channel separation, which has associated photodetectors for signal verification, whose signals are applied to an evaluation unit.

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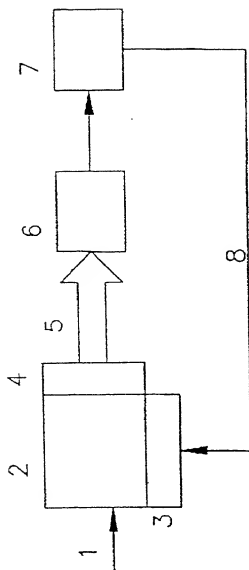


Fig. 1

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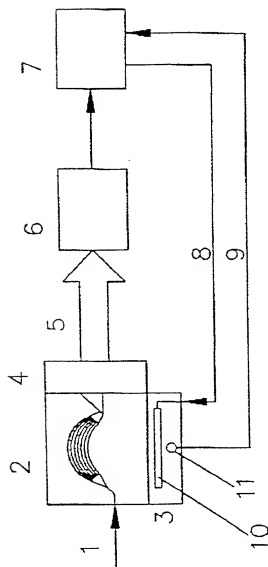


Fig. 2

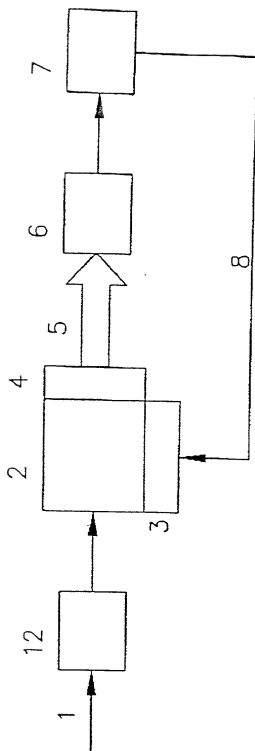


Fig. 3

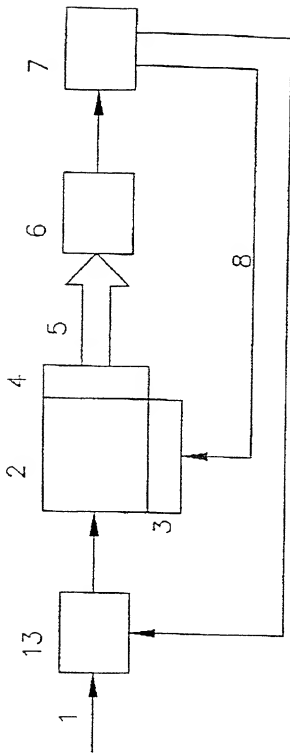


Fig. 4



COMBINED DECLARATION AND POWER OF ATTORNEY (PATENT - ORIGINAL, DESIGN, NATIONAL STAGE OF PCT)

#4

As a below named joint inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is of the following type: (check one applicable item below)

- ☐ Original
☐ Design
☒ National stage of PCT

INVENTORSHIP DECLARATION

My residence, post office address and citizenship are as stated below next to my name, I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: ASSEMBLY FOR MONITORING THE PERFORMANCE OF D-WDM MULTI-FREQUENCY SYSTEMS.

SPECIFICATION IDENTIFICATION

the specification of which:

- ☒ is attached hereto.
☐ was filed on _____ as Serial No. _____
 and was amended on _____ (if applicable).

NOTE: Amendments filed after the original papers are deposited with the PTO which contain new matter are not accorded a filing date by being referred to in the declaration. Accordingly, the amendments involved are those filed with the application papers or, in the case of a supplemental declaration, are those amendments claiming matter not encompassed in the original statement of invention or claims. See 37 CFR 1.67.

- ☒ was described and claimed in PCT International Application No. PCT/DE00/01267 filed on 25/APRIL/2000 and as amended under PCT Article 19 on _____ (if any).

ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Office all known information which is material to patentability as defined in Title 37, Code of Federal Regulations. § 1.56.

- ☐ In compliance with this duty there is attached an information disclosure statement. 37 CFR 1.97.

PRIORITY CLAIM

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States

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America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

no such applications have been filed.

such applications have been filed as follows.

NOTE: Where item (c) is entered above and the International Application which designated the U.S. claimed priority check item (e), enter the details below and make the priority claim.

**EARLIEST FOREIGN APPLICATION(S), IF ANY FILED WITHIN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION**

Country	Application Number	Date of Filing	Priority Claimed under 37 U.S.C. 119
INTERNATIONAL	PCT/DE00/01267	25/APRIL/2000	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
DE	199 18 630.8	23/APRIL/1999	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No

**ALL FOREIGN APPLICATION(S), IF ANY FILED MORE THAN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION**

POWER OF ATTORNEY
As a named inventor, I hereby appoint the following registered practitioners to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: otherwise known as customer no. 08933

Lewis F. Gould, Jr., Registration No. 25,057; William H. Murray, Registration No. 27,218; Stephan P. Gribok, Registration No. 29,643; Peter J. Cronk, Registration No. 32,021; Robert E. Rosenthal, Registration No. 33,450; Richard A. Paikoff, Registration No. 34,892; Samuel W. Apicelli, Registration No. 36,427; Steven E. Koffs, Registration No. 37,163; Gail A. Dalickas, Registration No. 40,979; Darius C. Gambino, Registration No. 41,472; Anthony Colesanti, Registration No. 42,428; Joseph A. Powers, Registration No. 47,006; Melanie Goddard, Registration No. 46,732 and Joseph F. Oriti, Registration No. 47,835.

Please direct all correspondence to: Stephan P. Gribok, Esq.

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One Liberty Place
Philadelphia, PA 19103
Telephone (215) 979-1282

DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the application or any patent issued thereon.

MAR 13 2002

SIGNATURE(S)

1-00 Full name of first joint inventor, Adalbert BANDEMER
Inventor's signature [Signature]
Date _____ Country of Citizenship Germany
Residence Dachau, Germany DE
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2-00 Full name of second joint inventor, Dieter PALME
Inventor's signature [Signature]
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Residence München, Germany DE
Post Office Address Abensbergstrasse 47, D-80993, München, Germany

Attorney Docket No: 3212-25

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